ENGINEERING NEWS.

Tribune Building, New York City.

GEO. H. FROST, PROPRIETOR.

SATURDAY, MARCH 12, 1881.

IN the New York State Senate the bill prohibiting the use of any portion of Central Park by the World's Fair, or any international exhibition, was favorably reported on the 9th inst.

WE publish this week the paper read by Mr. G. Bouscaren, before the American Society of Civil Engineers, on "The Strength of Wrought-Iron Columns." The tables of tests which accompanied this paper formed part of the article on "The Design Generally of Iron Bridges of very Large Span for Railway Traffic," by T. C. Clarke, C. E., and were published in ENGINEERING NEWS of Jan. 29, 1881.

PITTSBURGH people think they are in need of an elevated railroad, and, owing to topographical considerations, it is perhaps the only kind that will meet their requirements. The increase of population in the suburbs is very great, and it is believed that an elevated road would tend to still further enlarge it. Captain Andrews has proposed a plan, and though there is considerable opposition, the early formation of a company is very probable.

ON the 3d ult. a bill was introduced in the Legislature of Minnesota "To Provide a Better System of Land Surveys in this State." The bill was compiled from the one approved by the Convention of Civil Engineers and Surveyors of Pennsylvania, reported in ENGINEERING NEWS of Nov. 13, 1880, by M. B. Haynes, City Engineer, of Mankato, Minn. Although it failed to receive the votes necessary to make it a law, its promoters hope to secure the passage of this or a still better bill at the next session.

AT a meeting of the Board of Aldermen, of this city, held on the 8th inst., a resolution was introduced requesting the representatives of this city in the Legislature to pass an act compelling the various telegraph companies to place their wires under ground. This seems to be a step in the right direction, as the network of wires which is now spread over New York endangers life during the prevalence of a high wind or sleet storm similar to that which occurred about one month since, and prevents the most effective service of the fire department.

THE average alderman has never been regarded as the highest type of intellectuality, but then there are some things which they might reasonably be expected to know. The Philadelphia Gas Trust Committee of Councils held a meeting last week. The Superintendent of the Gas Works explained the causes of leakage. An explanation of the manner in which the flow of gas could be manipulated by a governor in the works gave one of the aldermen a chance. After a few questions as to the former experience of the witness, the latter informed the 'Squire that there was no governor at the Correction Works.

"Well," asked the municipal expert, "how then can you tell your candle power?"

A loud laugh from the Committeemen and spectators greeted this exhibition of scientific knowledge on the part of the 'Squire, who added to the general merriment by asking if there wasn't a meter on the grounds by which the candle power was measured.

THE policy of the new administration in regard to the various schemes for building canals across the isthmus connecting North and South America is clearly defined in the following abstract from the inaugural address of President Garfield:

"The development of the world's commerce has led to an urgent demand for shortening the great sea voyage around Cape Horn by constructing ship canals or railways across the isthmus which unites the two continents. Various plans to this end have been suggested and will need consideration, but none of them has been sufficiently matured to warrant the United States in extending pecuniary aid. The subject, however, is one which will immediately engage the attention of the Government with a view to a thorough protection of American interests. We will urge no narrow policy, nor seek peculiar or exclusive privileges in any commercial route, but, in the language of my predecessor, I believe it to be the right and duty of the United States to assert and maintain such supervision and authority over any inter-oceanic canal across the isthmus that connects North and South America as will protect our national interests.'"

PERSONAL.

Mr. John W. Clarke, of Allegheny, has left for the City of Mexico, where he joins a surveying expedition of the Mexican National Railroad. Mr. Clarke expects to be gone about three years.

On the 7th inst., Arthur Strabos, a civil engineer who went from this city a few months ago to Pittsburgh, to perfect the plans for the Monongahela Bridge, died in that city. In compliance with his request, his body was taken to Washington, Pa., for incineration.

Mr. Emile Low, late Chief Engineer of the Pittsburgh & Western Railroad, was in New York on Thursday, en route to Mexico by the steamer *City of Mexico*, which sailed at 3 P. M. of that date. Mr. Low is engaged as First Assistant Engineer under his father Sigismund Low, late of the Baltimore & Ohio Railroad, and who now goes out in the service of the Mexican Central Railroad Company, with orders to report at the office of General Manager Rudolph Fink, City of Mexico.

The following party of civil engineers left by the *City of Mexico* on Thursday for Mexico, in the service of the Mexican National Construction Co., with order to report at headquarters, City of Mexico: A. M. Wellington, of Cleveland, O., chief of party; H. H. Filley, late Assistant City Engineer of Toledo, O.; Ambrose E. Lehman, Philadelphia; Geo. H. Birnie, Jno. W. Clarke, J. S. Elliott, J. W. Adamson, J. W. Gallup, T. R. Countryman, Max Classman, Granville Jones, Auguste Martin, Thos. F. O'Brien, Geo. A. Hopkins, Reuben B. Foster, Geo. W. Charlton, W. G. Cleveland, N. P. Sacket, Jr., G. M. Grout, Rollin Crowell.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page 93.*)

For the supply of the islands in the East River, on which the penal and charitable institutions of New York are situated, submerged pipe are laid. Randall's and Ward's islands were supplied in 1846 through two 3 in. and one 3¼ in. lead pipes, laid in wooden trunks across the bottom of the river.

The bottom between the city and Blackwell's Island is irregular, with ridges of rock running longitudinally.

In 1850 a flexible gutta-percha pipe was laid across. Some of the anchors used to keep it in place became displaced, and about 50 ft. of the pipe was moved backward and forward by the tides, and holes were worn in it.

In 1851 this pipe was repaired, and another and a heavier one of the same material laid. In 1852 it was broken by the dragging of a vessel's anchor and again replaced. In 1869 these pipes were again broken and repaired. In the same year an 8-in. cast-iron pipe, lined with 4 in. of wood, was laid across the Harlem River at 121st street, to Randall's Island. The lining of wood was inserted to prevent the freezing of the water in the pipe, which had occurred in the other pipes laid under salt water. Several times the ice had to be removed by pumping hot brine into the pipe.

In 1870 the gutta-percha pipes were replaced by 3-in. pipes of wrought-iron. Both of these were broken in 1871 by the dragging of a vessel's anchor. In place of them, Mr. Tracy laid a 6-in. wrought-iron lap-welded pipe, the joints made with heavy screw couplings and strengthened by cast-iron sleeves with leaded joints. The pipe, 1350 ft. in length, was put together on land and inclosed in on oak case bolted and riveted together, the space around the pipe being filled with cement. The box was saturated with coal tar and then was hauled across the river by chains from a steam capstan. The pipe and box weighed 200 tons, and were laid in water 100 ft. deep.

Similar pipes were laid to Ward's Island in 1874 and to Randall's Island in 1876. A 10-in. pipe, similarly constructed, was laid across the Harlem River at the end of Second avenue in 1874, to supply the newly annexed territory across the river.

STORAGE RESERVOIRS.

The daily consumption having become greater than the ordinary daily flow of the Croton River in dry seasons, two storage reservoirs have been constructed by building dams across valleys on branches of the Croton.

The first on the West Branch was begun in 1866 and completed in 1873. The second on the Middle Branch was completed in 1878. Fourteen natural ponds have also been made available as storage basins. The aggregate capacity of the storage is 9,000,000,000 gallons, or 1.528 in. of rainfall on the Croton water shed. The cost of the construction of these reservoirs, including land and water damages and engineering expenses, has been $2,050,000, or about $230 for every million of gallons stored. The topographical survey of the Croton Valley, made under the direction of Mr. Craven in 1858, showed that there are thirteen other sites at which it will be practicable to build storage reservoirs with a capacity of 9 inches of the rain fall.

HIGH SERVICE.

A supply for higher elevations than the aqueduct is furnished by two steam engines at High Bridge, each of 5,000,000 gallons capacity per day. These engines were constructed after designs of William E. Worthen, C. E., and were erected, one in 1870 the other in 1876. The first Worthen engine, when tested for acceptance, was certified by Mr. Horatio Allen to have exceeded the contract requirements for duty by 10 per cent., and for delivery 15 per cent.

Contrary to the universal custom in the United States, the Department of Public Works has never published any statements of the annual duty and cost of operation of these engines.

The high service supply has been extended far beyond the limits for which it was originally intended, a 20 in. main having been laid from High Bridge to Forty-second street, about 7 miles, supplying a considerable area in that vicinity which suffered from deficiency of head from the reservoir supply.

Additional high service supply is now furnished by two engines built in 1879–80 by the late Henry R. Worthington, C. E., at Ninety-eighth street, pumping into a stand-pipe 170 ft. high.

The capacity of the original aqueduct being exceeded by the demand, works for an additional supply from the Bronx River, which has a water shed of 13 square miles, are now constructing. These works consist of a storage reservoir and a line of 48-in. cast-iron pipe, 20 miles long.

The population, pipeage and consumption at

* Copyright 1881.

each tenth year since the introduction of the present supply have been as follows:

Year.	Population.	Miles of Pipe.	Daily Consumption in Millions of Gallons.
1850.....	515,547	205.61	40
1860.....	813,669	272.73	55
1870.....	942,292	336.43	75
1880.....	1,206,500	500	95

WATER RATES.

The rates imposed by the Manhattan Company before the Croton works were built were proportioned to the number of fire places in the houses. Small houses having from one to three fire places were charged $5 per year, and the largest houses $15, the average being $9.63 for each family and $3 for each family more than one in a house.

On the introduction of the Croton water, all buildings on streets in which water mains were laid were taxed according to frontage, and additional rates charged for the use of water. The same principle is still maintained. The rates charged will be given hereafter.

The use of meters was begun in 1851. For some years the reports state that the only reliable meter was one invented by Samuel Huse, costing from $35 to $450 each. Ten were in use in 1852.

In 1855, meters were applied to 68 large hotels and manufactories.

From that time to 1870 the number was increased slowly, there being difficulties in the way, in consequence of the cost and the opposition from large consumers. By a law of 1870 the Commissioner of Public Works was authorized to put meters on all buildings, and a contract was made with one firm to furnish 10,000 at $70 each. Four thousand of these were delivered, but tests made by a board of engineers proved that that type of meter was not to be relied upon for accuracy or durability, and none of them have been used. A litigation of several years ensued, resulting in a judgment against the city for $1,126,-148.13 for this useless material. Under the existing law meters may be applied to any building in which water is used for business purposes, the consumer to bear the cost of the meter and pay for the water used at rates fixed by the authorities. This rate was 15 cents for every 100 cubic feet prior to April 15, 1880, when it was reduced to 7½ cents.

The frontage tax is not charged on buildings in which meters are used.

The systematic introduction of meters was not begun until January, 1878, at which time 260 were in use. By Sept. 30, 1880, the number had been increased to 3,314, and it is proposed to place altogether about 10,000.

The consumption of water averages, in the buildings already metered, about 5,000 gallons per day.

There are 77,000 taps or connections with the mains in the city.

The excessive waste of water has been a constant source of annoyance to the authorities, and various modes of inspection have been tried. The one most favored at present is by means of Church's water-gauge, a small instrument which may be placed at the house inlet, and which registers the quantity flowing in the house at all times, showing whether there is a waste during improper hours. These are now in use on 14 houses for trial, and showed at first an average waste during the night hours of 17 gallons per hour per house, which was found to be mostly caused by defective plumbing.

ORGANIZATION.

The works were built under a commission appointed by the Legislature. From 1842 to 1849 they were managed by a board appointed by the Common Council.

In 1849 the Croton Aqueduct Department, consisting of three commissioners, one of whom was a civil engineer, was constituted. The members held office for five years, and were appointed by the mayor and aldermen. Mr. Alfred W. Craven was chief engineer and commissioner from July, 1849, to May, 1868, having been reappointed for several successive terms—a result due to the eminent ability and thorough integrity with which the department was managed by him. He was succeeded by General George S. Greene, who retained office until 1870, when the Croton Aqueduct Board was abolished and its powers transferred to a commissioner of public works, who appointed a chief engineer.

Mr. Edward H. Tracy was so appointed and held the position until his death in 1875, when Mr. John C. Campbell was appointed. He still holds the position. Mr. George W. Birdsall was acting chief engineer from October, 1878, to October, 1880. The commissioners of Public Works have been William M. Tweed, George M. Van Nort, Fitz John Porter, Allan Campbell and Hubert O. Thompson, the present incumbent.

The cost of the original works up to April 1, 1843, was $11,452,019. To September, 1880, the total cost of all works connected with the supply, and the repairs and maintenance of the same, had been $37,212,995.74; the revenue to the same date had been $36,363,953.81.

II.—PHILADELPHIA.

The city of Philadelphia is situated on the west bank of the Delaware River, 96 miles from the ocean. The extent of the corporate limits is 13 miles from north to south, and 10 miles from east to west, embracing the old city between the Delaware and Schuylkill rivers, 4 to 8 miles wide, and the surburban towns west of the Schuylkill, which were annexed to the city in 1854. It covers an area of 129.2 square miles.

The old city is flat, being all less than 40 ft. above the rivers. West of the Schuylkill and north of the original site of the town, the ground rises rapidly and is intersected by the valleys of several small streams, creating a very undulating surface, rising to nearly 400 ft. elevation.

Settled in 1682, the city had attained in 1798 a population of about 80,000, who drew their water supply entirely from wells. In this year, Benjamin H. Latrobe, C. E., by order of the Common Council presented a scheme for introducing water from the Schuylkill River. The works were begun in March, 1800, and the first water supplied from them Jan. 27, 1801.

The Schuylkill River has a drainage area of about 1,800 square miles. The upper portion is mountainous, and contains many coal mines, the water pumped from which is very impure and frequently pollutes the stream to such an extent that it kills or drives out the fish. At the city, however, it is of moderate purity.

In 1865 it was stated that at about six miles above Reading, which is some 50 miles from Philadelphia, the river water was charged with 9.888 grains of sulphuric acid to the gallon. Above this point the water is unfit for manufacturing or culinary purposes. Below this point it receives the water of several tributaries which drain large sections of limestone country. After the mingling of their waters, the Schuylkill contains 1.508 grains of sulphuric acid to the gallon, which proportion is maintained until it reaches Philadelphia.

The minimum recorded flow of the stream is 0.21 cu. ft. per second per square mile or 245,000,000 gallons per day.

The annual discharge is remarkably small, according to the computations of C. G. Darrach, C. E. (ENGINEERING NEWS, vol. VII., p. 122), having been as follows:

1877.....	16.44 inches	on water-shed.
1878.....	11.28 "	" "
1879.....	8.51 "	" "

The works erected by Mr. Latrobe consisted of

(1) A basin on the Schuylkill River, 84 ft. wide, and extending 200 feet into the stream, provided with tide-lock gates. The bottom was 3 ft. below low water.

(2) A basin, 40 ft. wide and 160 feet long, which received water from the first basin through a sluice.

(3) An oval tunnel, 6 ft. high and 300 ft. long, through rock, its bottom at low-water level.

(4) A well 10 ft. in diameter and 39 ft. deep, in which was placed a double acting force pump, 17½ in. in diameter and 72 in. stroke, operated by a steam engine with a cylinder of 40 in. diameter and 72 in. stroke, which raised water into a brick conduit 3,144 ft. long and 6 ft. diameter, which conveyed it to Centre Square, where it was lifted again by a pump 18 in. diameter and 72 in. stroke, worked by an engine of 36 in. diameter of cylinder, with 72 in. stroke, into two wooden tanks 50 ft. above the conduit bottom, or 36 ft. above the ground.

The tanks held 20,868 gallons, and the water passed from them into an iron chest 4 by 8 ft. outside the building, and thence was distributed through 6 in. bored logs, reduced farther on to 4½ in., 4 in. and 3 in.

The river basins were lined with marble and the Centre Square engine house built of the same material. The engines were principally of wood, and the boilers were wooden boxes, the fire box being wrought iron with vertical flues of cast iron. These boilers leaked badly, and in December, 1804, one with cast-iron shell, as well as flues, was erected and another in 1806. These were used until 1815.

The steam cylinder of the Centre Square engine was of cast-iron, in two pieces, united by copper and the joint covered with a cast-iron band. The boring of the cylinder took over four months, at the Soho Iron-Works, near Newark, N. J.

The contract price of the engines was $30,000, but the contractor claimed that they cost him $77,192. In 1809 the expense of operating them was $13,807.23.

Up to 1815 the total cost of the works and their maintenance had been $657,398.91, the gross revenue had been $105,351.18.

In 1811 John Davis and Frederick Graff reported to the Common Council in favor of a further supply by steam works at Fairmount, and their report was adopted. The works, begun Aug. 1, 1812, and put in operation Sept. 7, 1815, consisted of a Bolton & Watt engine, of 44 in. cylinder, and 72 in. stroke, working a double-acting pump of 20 in. diameter and 72 in. stroke, raising the water through a 16-in. main 239 ft. long into a reservoir 102 ft. above the river, containing 3,280,-265 U. S. gallons, whence the water was conveyed by five lines of 6-in. wooden logs and one of 4½-in., for 9,337 ft., to the distributing chest at Centre Square.

In 1817 an Oliver Evans high pressure engine was added, with cylinder of 20 in. diameter and 60 in. stroke, working a pump of 21 in. diameter and 48 in. stroke. The cost of running this engine for a year, pumping 2,300,000 gallons per day, was $30,858.75, or 36 cents per million gallons raised one foot.

In 1818 the plans of Frederick Graff for a supply by water-power from the Schuylkill at Fairmount, were adopted, and the works put in operation July 1, 1822.

The river here was about 900 ft. wide. The bottom was of rock, and for one-fourth of the distance on the east side was covered with 11 ft. of mud. The greatest depth at high water was 30 ft., and it shoaled gradually to the west shore.

A dam was built here, which on the rock bottom was formed of log cribs, about 50 ft. up and down stream, and 17 to 18 ft. wide, filled with stone, planked on the upper side, and backed up with earth and carried up to 13½ ft. above low tide.

On the mud bottom the dam was made of stone spalls and earth, 150 ft. wide at the bottom and 12 ft. at the top, which was 15 ft. above the other part of the dam. The top and up stream slope were paved with stone three feet thick. A stone pier between the bank and the overfall protects the bank or mound dam.

The dam was built obliquely to create an overfall of 1,204 ft. in length. The earth or mound dam was 270 ft. long, and a wall with arches to convey water to the wheels was 104 ft., making the dam, inclusive of a head pier and guard lock for a canal on the west side, 1,600 ft. long. This backed the water up six miles.

The hemlock crib-work of the dam was rebuilt above low water in 1842-3 with white pine, with overfall of 1,148.83 feet.

This work was done in coffer dams, at great expense and risk.

In 1865, the dam being a good deal dilapidated, cribs 30 ft. wide were placed below it for 450 ft. of its highest part, and divided into compartments 8 ft. square, filled with stone.

They were of round hemlock timber below low water, finished with hewed white pine and decked with white oak timber.

In 1872 a new dam was built directly in front of the old one, upon the rock at the west end, and upon the cribs sunk in 1865.

The original down-stream face was nearly vertical.

The new overfall was made with two inclined aprons, with a drop between them, the lowest part being 2 ft. above low water. The space between the old and new dams was filled with concrete, about 6 ft. wide at the top.

PUMPS.

The first pumps were horizontal, double-action force pumps, of 16 in. diameter, and 72 in. stroke, but worked at 54 in. stroke, driven by breast wheels, one of 15 ft. diameter and 15 ft. long, and two of 16 ft. diameter and 15 ft. long, working under 1 ft. head and 7½ ft. fall when the tide was low.

The tide rose 2 ft. above their lower edge, preventing their working from 4 to 6 hours every day. These wheels worked for 24 years and were then replaced.

As the consumption of water increased other wheels were added, respectively, in 1827, 1832, 1834, and two in 1843. In 1851 a turbine wheel was added, and in 1862 an additional wheel-house was built to utilize the surplus during several months. Three Jonval turbines were put in, each working two double-acting pumps of 18 in. diameter and 72 in. stroke.

In 1869 two of the old breast wheels were removed and replaced by a turbine, two more in 1870 and two more in 1871. There are now in use seven turbine wheels, which, in 1879, ran 52 per cent. of the time, pumping 20,000,000 gallons per day into the reservoirs. The full capacity of the pumps is 36,000,000 gallons per day. The water power is deficient in summer, and during twelve consecutive days in 1879 only 8,000,000 gallons per day could be pumped.

A Worthington steam pump was placed in these works in 1872 to supply the deficiency in the summer months.

(TO BE CONTINUED.)

We are pleased to acknowledge the receipt of reports of the Board of Water-Works, of Dayton, Ohio, from Jos. E. Waltz, City Civil Engineer; A Table of general Information Concerning the Water-works of the United States and Canadas, and a pamphlet entitled "The Holly System of Water Supply and Fire Protection" from C. G. Hildreth, Secretary of the company; the fourteenth report of the Water Commissioners of Waterbury, Conn., from Welton and Bonnett, civil engineers; report of W. W. Brigden, City Civil Engineer of Erie, Pa., for year 1880; reports of Water Commissioners of the City of Hudson; reports of Board of Water Commissioners of Detroit, from Henry Starkey, secretary; preliminary report of J. D. Cook, C. E., of Toledo, O., for water-works for the City of Springfield, O.; specifications for constructing water-works for the Thomaston Water Company, of Thomaston, Conn.; report of the Superintendent of Water Works of Lancaster, Pa., and the eleventh annual report of the Acushnet Water Board of the City Council of New Bedford, Mass., from Wm. B. Sherman, Superintendent.

SURVEYING, LAYING OUT AND MONUMENTING THE NEW WARDS OF NEW YORK.*

BY S. S. HAIGHT, CIVIL ENGINEER AND CITY SURVEYOR, WEST FARMS, NEW YORK.

IV.

The monuments are all numbered, there being a separate series of numbers for each sheet. These numbers are cut in the side of the stone near its top, in Arabic numerals the number of the sheet being cut on the reverse side in Roman numerals. The number of each monument is shown in its proper place upon the map. Where the park plan was not adopted, but the streets form angular corners, the monuments are usually set at the intersections of lines drawn through the streets parallel to the side lines and ten feet distant therefrom. On Jerome and Webster avenues the monuments are set on the center lines. On Sedgwick avenue and Mosholu avenue they are on the side lines, making their use by surveyors very difficult, on account of fences. In Morrisania and on the Southern Boulevard, Fordham avenue, and Boston Road, in West Farms, they were placed in the streets, *five* feet from the side lines; but the unfortunate power of the aldermen to authorize the building of fences, stoops and bay windows more than that distance in the streets, made it necessary to have a greater offset for the monument lines; so ten feet was made the rule.

During the time that the Riverdale District was being monumented, the work was thoroughly systematized; such a division of labor being made as to promote the greatest rapidity of work consistent with necessary accuracy.

Several members of the engineering force had been for years engaged upon the work, were heartily interested in its success, and owed their retention in place to their proved efficiency.

Because of the neglect of most of those employed to meet the requirements of the political party then in power by contributing to its election expenses, the influence of its chief in New York was used in the Board of Apportionment to make the appropriation for the work in 1878 only $10,000, a like amount having been appropriated each year since that time. As this sum was but two-fifths of that used the previous year, the reduction of appropriation caused a suspension of the work.

Previous to the suspension, all who had responded to the party call had been cared for by being transferred to the work of constructing Riverside Drive, with a large increase of salary in most cases. The appropriation for "Surveying, Laying Out and Monumenting," having become nearly exhausted, at the meeting of the Board held on the 27th of March, 1878, a resolution was adopted suspending, without pay, the civil and topographical engineer and all others employed upon the work, excepting two draughtsmen; and placing the office in charge of Mr. E. B. Van Winkle, the engineer of street openings. Mr. Van Winkle was afterward appointed Topographical Engineer, which is his present title, while he also has charge of the preparation of maps for the Commissioners of Taxes and assessments, and is acting construction engineer during the absence in Mexico of Mr. Wm. J. McAlpine.

In June following the suspension, a few of the former employés were temporarily re-engaged for the purpose of monumenting Boston Avenue in Morrisania and West Farms, and afterward for the Spuyten Duyvil Parkway extension, and for Bailey and Sedgwick avenues, near Kingsbridge.

The heirs of the Fox estate in West Farms advanced money to the department for the purpose of monumenting the streets of the plan that had been previously adopted for their land:* so work was started there immediately upon the completion of that upon Bailey avenue.

In the exterior traverse of the Fox estate there were twelve angles, and the aggregate errors were six seconds, or half a second per angle.

The length of lines in this exterior traverse aggregated three miles, and calculation showed the combined errors of latitude and departure to be three inches.

This monumenting was completed in December 1878, when those employed in the field-work were again suspended, but were re-appointed in February following.

Since then the changed lines of numerous streets in Morrisania have been monumented; also the extension of Sedgwick avenue from Kingsbridge road to Oloff Park; the avenues and streets of a broad strip along the Harlem Railroad from Morrisania to Fordham; a part of the Boscobel district, near High Bridge; a part of the West Farms district, including the village of West Farms; and a part of the Hunt's Point district, adjoining the lands of the Fox estate upon the north, south and west. During the past winter, traverses have been measured and calculations made preliminary to monumenting at Brightside (land of Col. R. M. Hoe); and at Fairmount (between Fremont and West Farms).

The remaining area is so extensive that the completion of the work will be a labor of years, unless the appropriations are largely increased; notwithstanding the fact that the salary paid to some of those doing the most important part of the work is only half that for which they were originally engaged; mere clerks in some other departments of the city government receiving twice the sum now paid to the Topographical Engineer, who receives less than some of the clerks in his own department.

During the time that this work has been in progress, Robert L. Cooke, George A. Cushing and C. Ridgeley Schott, Division Engineers; Isaac Halstead, Rodman; and Thomas L. Beebe, Axeman, have been taken from all earthly labors, though, of these, Mr. Halstead alone was in the employment of the department at the time of his death.

Besides those whose names have been mentioned, the following persons (not now employed upon the work) have given valuable and efficient services: John S. Newlin, Division Engineer (Twelfth Ward); Samuel B. Smith, Frederick S. Odell and John F. Perez, Assistant Engineers; George C. Hollerith, Randall Hunt and Daniel Bontecou, Assistants; Matthew Cox and F. DeLacey Underhill, Rodmen;

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*In the correction on page 96 the error in the name of the Morrisania contractor is repeated; the first letter of Mr. Mason's name is L. The "at" immediately preceding "Mt. St. Vincent" at bottom of sixth paragraph of first column should be omitted.

In the lower line of the sixth paragraph from the top of the middle column there should be no comma after "tangent," and the word "street" should be transposed so as to immediately precede "intersection," making it read "of every tangent point and street intersection." In the ninth paragraph of middle column "center line" should be "center lines," and "was established" should be "were established."

In the last paragraph, instead of "The *streets* and blocks are numbered" it should have been "The *sheets* and blocks."

*A bill was afterward introduced into the Legislature authorizing the repayment of the money so advanced, but it failed to become a law, some of the New York papers, particularly the *Times*, treating it as an attempted fraud. In the interest of justice it may be hoped that such an Act will yet be passed, as there is no good reason for obliging them to bear all the cost of the city's monumenting those streets and then be taxed for the cost of similar work on land of their neighbors.

Effingham M. Clock and S. Gerow Carpenter, Chainmen; and Emil Huesner and Timothy J. O'Sullivan, Draughtsmen. Mention should also be made of Mr. Eugene C. Morrison, who, as assistant of George S. Greene, Jr., sets points that have been connected with the department surveys with less error per mile than that allowed for 1,000 feet.

Those now in the service and engaged upon the monumenting and upon the preparation of the tax maps are: E. B. Van Winkle, Topographical Engineer; F. Greiffenberg, Assistant Engineer and Draughtsman; S. S. Haight and H. W. Vogel, Assistant Engineers; J. A. Briggs, Surveyor; H. Mehles, Draughtsman; H. Crosby, S. W. Hoag, Jr., O. H. Rogers, P. R. Buckelew, C. H. Graham and T. Fox, Assistants and T. Tousley, Axeman.

NOTES ON THE ACTION OF FURNACES, BOILERS AND STEAM ENGINES.

(*Continued from page* 74.)

VII.

CLEARANCE—COMPOUND ENGINES.

Clearance is a term used to include, not only the space between the piston and the end of the cylinder to which it is nearest at the beginning of a stroke, but also the volume of the ports. This space, as well as the space through which the piston sweeps, has to be filled with steam. The clearance, for purposes of calculation, is expressed as a fraction of the space swept over by the piston during a single stroke. Let A be the area of the piston, H the length of its stroke; then

$$\frac{\text{volume of clearance}}{A\,H} = c,$$

the fraction above.

Length of cylinder equivalent to the clearance $= c\,H$.

If the engine has clearance, there is more steam to expand than is apparent from the point of cut-off, and the expansion curve, the work of expansion and the mean forward pressure will be changed. The formulæ of Art. V. will then be modified as follows:

The work before expansion will be unchanged.

$$A\,p_0\,h_0$$

The work during expansion $=$

$$A\,p_0\,(h_0 + c\,H)\int_{v_0}^{v_1}\frac{dv}{v} = A\,p_0\,(h_0 + c\,H)\,log.\frac{H + c\,H}{h_0 + c\,H}$$

The work of back pressure $=$

$$-p_2\,A\,H = -p_2\,V_1.$$

Therefore the total work of the steam for one stroke

$$E = A\,p_0\left[h_0 + (h_0 + c\,H)\,log.\frac{H + c\,H}{h_0 + c\,H}\right] - p_2\,A\,H.$$

If the apparent expansion $r = \dfrac{H}{h_0}$; and $A\,H = V_1$,

$$E = p_0\,V_1\left[\frac{1}{r} + \left(\frac{1}{r} + c\right)log.\frac{1 + c}{\dfrac{1}{r} + c}\right] - p_2\,V_1.$$

$$= \frac{p_0}{r}\,V_1\left[1 + (1 + c\,r)\,log.\frac{r + c\,r}{1 + c\,r}\right] - p_2\,V_1,$$

and the mean *forward* pressure will be

$$p_m + \frac{p_0}{r}\left[1 + (1 + c\,r)\,log.\frac{r + c\,r}{1 + c\,r}\right].$$

The real rate of expansion,

$$r' = \frac{H + c\,H}{h_0 + c\,H} = \frac{r + c\,r}{1 + c\,r}.$$

The clearance will be set off as a fraction of the stroke at the beginning of the diagram, as shown in the figure of Art. V., where the distance from the left of the diagram to the vertical line is the fraction of stroke referred to. In constructing the expansion curve the point where the horizontal line through B cuts this vertical will be used in place of A in the figure of Art. VI. While the curve will therefore run slightly above that of the figure, and the diagram will inclose a somewhat larger area, it does not follow that work is done per pound of steam, as more steam is used to produce this increased area.

If the exhaust valve is closed before the end of the stroke, the vapor remaining in the space in front of the piston will be compressed and the pressure may be considerably raised, thus serving two purposes—one to absorb some of the momentum of the reciprocating parts, and to assist, as a cushion, in bringing the piston to rest; the other to diminish the effect of clearance by requiring, on the return stroke, less steam from the boiler to fill the space with steam of the initial pressure.

The preceding investigations may also be applied to a compound engine, where the steam, after expanding in the first, or high pressure cylinder, passes to the low pressure cylinder and is expanded further. If the steam passes from the first cylinder to the second without going into a receiver, the mean forward pressure in the second cylinder may be taken as the mean back pressure in the first cylinder. By drawing an expansion curve in the figure of Art. V. from C down toward the left, the upper portion of the diagram will represent the action of the steam on the first piston and the lower portion its action on the second piston.

Thus, a certain compound engine has cylinders of 18″ and 38″ diameter, and 8 ft. stroke; initial pressure of steam 89 lbs. above atmosphere; clearance of first cylinder, 2.43 per cent. of stroke, of second cylinder, 1.68 per cent.; cut-off at 30 per cent. in first cylinder; revolutions, 16¼ per minute; back pressure in second cylinder, 1⅛ lbs.

Then, in first cylinder

$$p_m = p_0\left[\frac{1}{r} + \left(\frac{1}{r} + c\right)log.\frac{1 + c}{\dfrac{1}{r} + c}\right] = \left(89 + 15\right)\left[0.3 + .3243\;log.\frac{1.0243}{0.3243}\right] = 70\text{ lbs.}$$

Terminal pressure in first cylinder will be

$$p_1 : p_0 = h_0 + c : H + c \text{ or } p_1 = p_0\frac{h_0 + c}{H + c}$$

$$p_1 = (89 + 15)\frac{0.3243}{1.0243} = 32.9\text{ lbs.}$$

The volumes of the two cylinders, having the same stroke, will be to one another as the squares of their diameters, or as 38^2 to 18^2, or 361 to 81, or 4.457 to 1. In the second cylinder, steam of 32.9 lbs. would therefore be expanded 4.457 times. The effect of the clearance in the second cylinder will be to reduce the initial pressure somewhat from 32.9 lbs.; but it will be sufficient for our purpose to use 32.9 lbs., and call the expansion 4.4 times. Then the mean forward pressure in second cylinder

$$p'm = 32.9\,\frac{log.\,4.4}{4.4} = 32.9\,\frac{1.48}{4.4} = 11.07$$

In the first cylinder, $p_m - p_2 = p_m - p'_m = 70 - 11.1 = 58.9$ lbs.

$$(p_m - p_2)\;V_1 = \frac{58.9 \times 3.1416 \times 18^2 \times 8}{4} = 119006\text{ ft. lbs.}$$

$$\frac{119006 \times 2 \times 16.25}{33000} = 118\text{ H. P. in 1st cyl.}$$

In the second cylinder

$$(p_m - p_2)\;V_2 = (11.1 - 1.5)\,\frac{3.1416 \times 38^2 \times 8}{4} = 87102\text{ ft. lbs.}$$

$$\frac{87102 \times 2 \times 16.25}{33000} = 86\text{ H. P. in 2d cyl.}$$

Total H. P. of engine $= 118 + 86 = 204$ H. P.

This quantity will be reduced by deducting area of piston-rods from area of piston, and by some modifications of diagrams to be referred to in Art. VIII. The actual indicator diagrams of this engine showed 195½ horse-power. The theory previously advanced therefore gives a very fair result.

This engine used 1.69 lbs. of Cumberland coal per indicated H. P. per hour, and 14 lbs. of steam. Water evaporated 8.27 lbs. per lb. of coal. The expansion in the two cylinders together is practically $3 \times 4.4 = 13.2$ times.

CORRESPONDENCE.

ADDITIONAL WIDTH OF GAUGE ON RAILWAY CURVES.

Livingston, Ky., March 9, 1881.

Editor Engineering News:

The "German" formula of which Mr. Dahll speaks in Engineering News of March 5, has as constant 0.03 instead of 0.3 as mentioned, the formula is $W = N(1{,}000 - r)$ in millimeters, W = widening of gauge, N is the constant, which varies from 0.015 to 0.03 and r the radius of curve measured from *center of track* to center point. The figure 1,000 (in meters) makes the widening of gauge equal to °, that is to say, at a radius of 3,280 feet or about a curve of 1°45′, the Germans do not widen the gauge any more, but regard such a curve in the light of a tangent, although the outer rail is slightly heightened.

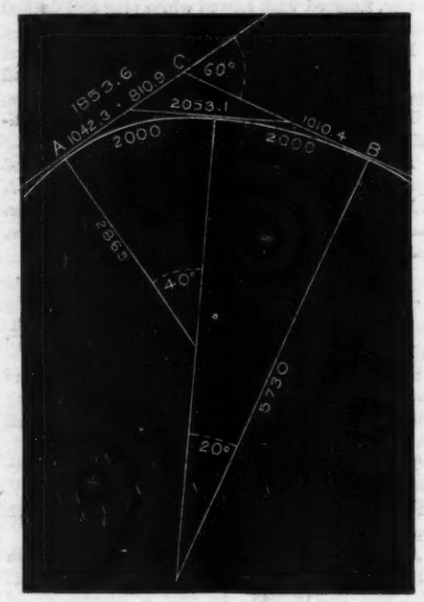
Correction.

PROBLEM IN RAILROAD CURVES.

High Bridge, N. Y., March 8, 1881.

Editor Engineering News:

I send the inclosed as an answer to L. E. Vel's problem in your last: Calculate the tangents of



the 2° and 1° curves, viz.: 1042.7 and 1010.4 respectively.

With their sum, 2053.1, as the side of the triangle opposite C, calculate the short side, 810.9, which, added to the tangent of the 2° curve, gives 1853.6, the distance required from intersection to PC.

A. J. Gavett.

[We have received solutions to the above problem from G. H. B., Wilmington, Del.; W. C. B., Boston, Mass.; W. H. A., Jersey City, N. J., and G. L. W., Danielsonville, Conn. The answers were identical with the one given.]

HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.

Kalamazoo, Mich., March 3, 1881.

Editor Engineering News:

Dear Sir: I will send you a report and historical sketch of the water-works from 1869 to 1881, which will be completed May 15, 1881. Please put us on the list. Wishing you success in your undertaking. Respectfully yours,

Geo. H. Chandler, Engineer.

Stillwater, Minn., March 4, 1881.

Editor Engineering News:

In Mr. Prince's list of water-works, published in your issue of Feb. 12 last, we notice he has us as a municipal instead of a private corporation.

We have a combination of systems here adapted to this *hilly* city. We started up November last. City commenced paying rental on eighty-five (85) hydrants in December. Any information you wish from us for your "History of American Water-Works" (which we think will be a grand success) will be gladly furnished.

Very respectfully, H. H. HARRISON,
Superintendent Stillwater Water Co.

NEW YORK, March 4, 1881.

EDITOR ENGINEERING NEWS:

In your issue of Feb. 12, I notice the following errors in your list of water-works in the United States and Canada, to wit:

Atlantic City and Phillipsburg, N. J., have no water-works. The works at Stroudsburg, Pa., is a private enterprise. Mount Job, Pa., should be Mount Joy, Pa., and to the list should be added Wilmington, N. C., which is also a private enterprise.

I heartily indorse the suggestion of Messrs. Goodhue & Birnie, of Springfield, Mass., and would further suggest that the miles of each size of pipe be given, the kind of pipe used, number of hydrants, if pumping works, what kind of machinery, and if operated on the direct stand-pipe or reservoir system; if gravity works, elevation of sources of supply, and its distance from centre of distribution, operating expenses, etc., etc.

Yours very respectfully,
J. A. CLOUD.

THE BRAZOS COAL FIELD, TEXAS.

No. 907 WALNUT ST., March 7, 1881.

EDITOR ENGINEERING NEWS:

In the notice of the Philadelphia meeting of the American Institute of Mining Engineers, published in ENGINEERING NEWS Feb. 26, I find a review of my paper on the Brazos Coal Field, Texas. Your reporter has stated facts not contained in my paper, and I hope you will publish my corrections in the next issue of the NEWS.

The economical geology of the State of Texas is at present attracting the attention of capitalists and geological engineers. The subject of my paper is a very important one economically, and I do not wish to be misrepresented in regard to my examination of the Brazos coal field. There are two *bituminous* coal beds contained in the coal strata proper, which aggregate 85 ft. thick, and lie between the carboniferous conglomerate and mountain limestone. The upper coal, known as the *Belknap bed* ranges from 2 to 4 ft. thick, is sulphurous and ashy on the outcrops, and has been known to exist for a great many years in Stephens and Young counties. It was first reported on in 1854 in the U. S. Pacific railroad reports.

The lower bed, which I have named the *Brazos*, occurs 50 ft. below the Belknap, and ranges from 4 to 6 ft. thick. The upper bed is 45 ft. below the surface at Fort Belknap. Both coal beds lie horizontal and contain very few undulations.

Very respectfully yours,
CHAS. A. ASHBURNER,
Engineer and Geologist.

A NEW WASTE WATER DETECTOR.

KANSAS CITY, Mo., March 8, 1881.

EDITOR ENGINEERING NEWS:

On the subject of "Water Supply of New York," a writer in the *Sanitary Engineer*, of 1st inst., speaks of an unperfected invention (presumably in New York) that it was hoped would find out who wasted water. I have recently at St. Louis examined such an invention, of which it can hardly be said that it is unperfected, and thinking it of sufficient interest for a description in your columns offer the following:

The value of the invention, if any, consists in the idea of what waste consists in. If that is correct, the question is not mechanically a difficult one, and is already so far perfected as to only require such changes of detail as are desirable before being placed in manufacture.

The device, in size and cost about one-half that of a cheap meter for the same-sized pipe, acts by closing the pipe automatically after a determined amount has passed through, or in a determined time, as may be desired.

When closed, it still permits a small quantity of water to pass, which quantity, it is considered, should be sufficient to prevent a reasonably protected pipe from freezing. In the one examined, this waste was about half a gallon per minute.

To regain the use of the pipes, it is necessary to close all faucets communicating with the "monitor," when, as soon as an equilibrium of pressure is attained on both sides of it, the automatic valve again drops and leaves the pipes open.

The argument is that a reasonable quantity of water may be allowed to waste to prevent freezing, but that such quantity can be predetermined and reduced to a minimum, and, that as no other use can be made of the pipes till the faucets are closed, as above, that such waste will not be made unnecessarily.

This apparatus, properly used, will never make its presence known; does not measure water or limit its use, and seems well adapted to uses where meters are objectionable; not having their need of attendance, can be placed more easily; and while of course not insuring that no water will be used unnecessarily, still acts in a manner that it would seem might be of great service in cities where such waste is otherwise almost impossible to properly reduce. It will be placed before the public this year.

G. W. PEARSONS.

ENGINEERS' SOCIETIES.

LIVERPOOL ENGINEERING SOCIETY.

The usual fortnightly meeting of this society was held on Wednesday evening, the 16th ult., at the Royal Institution, Colquitt street, Mr. A. Holt, M. Inst.C.E., in the chair. A paper was read by Mr. J. F. Aspinall on "Automatic and Non-Automatic Vacuum Brakes." The author first described the working of the "Smith Vacuum Brake," on the Great Southern and Western Railway of Ireland, pointing out some of the improvements which had been made in the working parts since its first introduction from America; these improvements having been suggested by the many practical men in whose hands the working of the brake has been placed on our railways. "Smith" sacks fitted to carriages for over four years, were found to be in good order, and apparently capable of lasting a much longer period. Great stress was laid by the author on the necessity of applying the brakes as gradually and lightly as possible, so as not to inconvenience the passengers. The steam valve on the engine is easily adjusted to produce a vacuum of 5 inches, which is quite sufficient for ordinary stoppages. The author then described the "Automatic Vacuum Brake," which he had patented, and which is in use on the London & South Western Railway, and other lines in England. After describing its working by means of diagrams, and pointing out its extreme simplicity on account of the absence of springs, and any parts requiring lubrication, the author made some observations as to the gear for applying the brake-blocks to the wheels. The system of placing them between the driving-wheels of the locomotives had not been found to work well on account of the jarring motion produced, and it had a bad effect on the coupling rods. A tensional gear giving a uniform pressure upon each wheel was stated to be best for use on carriages. A hearty vote of thanks to the author for his interesting paper closed the proceedings.

MICHIGAN ASSOCIATION OF SURVEYORS AND CIVIL ENGINEERS.

DEAR SIR: At our meeting just closed, the committee on Manual reported but little accomplished of actual compilation; but that, through correspondence with surveyors in this and other States, they have met with constant expressions of encouragement and of a real need felt for such a work. After discussion by the society, the committee was definitely instructed to proceed actively with the work. It is proper to say that the primary object in this work is to bring the practice in this State to a greater uniformity. It is contemplated to present in form for convenient reference the United States laws and decisions of courts. Then to present cases of actual occurrence, selected so as to cover, as far as possible, the whole ground of principles involved in our work. The committee undertakes this work in good faith and asks—nay, demands and must have—the active and hearty co-operation of all members of this society and of the profession generally—other States included. Therefore, of each surveyor who shall see this notice, we ask three things:

First. To send us at least one case from your practice—difficult or doubtful cases having the preference—giving plat and notes—the latter very full and complete, including oral evidence taken and how corners were marked. Care need be taken only to avoid errors, and not for the sake of appearance.

Second. Send us the magnetic declination of needle at your locality, describing your method of ascertaining it, and a history of its annual change as far as you know it. (Possibly this last may appear in your notes of survey of same line made in different years.)

Third. Give your views, hints, or suggestions as to the matter or form of what the Manual ought to be.

Give the matter your attention as soon as possible. Address any member of our committee, but preferably our chairman.

R. C. CARPENTER, Chairman, P. O., Lansing.
GEO. E. STEELE, P. O., Traverse City,
THOMAS LOVE, P. O., Avery, Berrien Co.
FRANCIS HODGMAN, P. O., Climax, Kalamazoo Co.
Jan. 14, 1881. Committee on Manual.

RENUMBERING THE STREETS OF DAYTON, OHIO.

An ordinance is now pending before the City Council of Dayton, Ohio, to renumber the houses. After stating the method to be pursued, the ordinance limits each number to twenty feet of ground, whether improved or vacant, provided that one hundred numbers shall be assigned to each square regularly laid out, and where there are regular squares laid out on one side and not on the opposite side, the squares laid out shall control the numbering. Section 4 states that it shall be the duty of the city numberer "to make plats of each street to be numbered in the alphabetical order of streets. Said plats to be executed on paragon mounted drawing paper of the size known as super-royal, similar to the gas plats of the city of Dayton, and shall show the numbers given to each lot."

These plots to belong to the city and to be kept on file in the office of the city civil engineer, under whose direction they are to be executed.

The numberer shall keep a record of the time and manner of services of notices, the issuing of numbers and certificates, the receips and disbursements. He also places the numbers of residences, business houses, etc.

In case persons are not found, he will advertise according to law and add the cost to the cost of certificates. He will make plats of new streets and report to Council whenever it becomes necessary to renumber any street. He shall "cause all numbers which have been obliterated or destroyed, to be replaced, * * * provided, the cost shall not exceed ten cents to the owner." All moneys collected he will pay to the city treasurer at the end of every three months. He will also have the names of streets placed on the building located at the corners of two streets.

The owners are given thirty days after the service of a notice in which to place the numbers; if the ordinance be not complied with the numberer will have them put on at the expense of the owner,

the amount being collected with other taxes as in in case of a special assessment.

The ordinance provides for the punishment by fine of any one hindering the numberer or any one appointed by him.

The City Civil Engineer shall be the city numberer.

[The above is a brief résumé of the ordinance now pending, and which was sent us by the City Civil Engineer, Mr. Joseph E. Waltz. The gas plats referred to in Section 4 are on a scale one inch to one hundred feet; the lots, lot numbers and dimensions are given. The streets are continuous; beginning at one end of street, it is drawn on the upper half of the street as far as it can, stopping at a cross street; it is then continued from the cross street on the lower half of the sheet, and, if necessary, on the next street. We would be pleased if city engineers would explain their method of renumbering streets.—ED. ENG. NEWS.]

ENGINEERING IN FOREIGN LANDS.

[Translated and prepared for ENGINEERING NEWS.]

At the last meeting of the Zurich Engineers and Architects Union, Herr Voegeli gave a lengthy account of his observations in the United States. He thought the success of the Brooklyn bridge and the Hudson tunnel very problematical.

A new system of traction by the use of compressed air has been successfully operated in Nantes. The following details of the method are given by the *Echo Industriel*. Steam is mixed with the air to limit the depression of temperature. The advantages of this combination are shown by the following calculations: When compressed air alone is used, and 0.17, being the specific heat, and 424 the mechanic coefficient of heat, we have: $0.17 \times 424 = 72$ kilogrameters. The initial temperature being 150°, it may be assumed that the cooling will not be over 50°. The force furnished by one kilogrameter of air will be: $72 \times 50 = 3{,}600$ kilos. In this case, a quantity of compressed air $1{,}292 \times \frac{273}{273 \times 15} \times 50 \times 72 = 4{,}412$ kilogrameters.

If we compress the air to thirty atmospheres, and use it until it is at five atmospheres, we have $25 \times 4{,}412 = 110{,}300$ kg. meters. A reservoir of 2.5 cu. m. is required to give one horse-power during an hour.

In the case of a mixture of air and steam at 100°, and applying the law of Mariotte, 1 kg. meter of air gives 0.264 cu. m., the power of which on a piston, with a valve of $\frac{1}{5}$, is $0.264 \times 5 \times 10{,}330$, or 25,000 kg. meters. The machine is of small size, and there is no noise. The amount of compressed air used depends entirely on the skill of the engineer. The Nantes tramways are 12 kilometers in length, and a reservoir of 2,800 liters and 100 kilos, of air saturated with steam at 100°, is sufficient for the motive power.

The French Board of Public Works has been transformed by the dismissal of the General Board of Engineers and the nomination of general inspectors instead. It is stated that the board was too arrogant, and assumed an arbitrary power.

The French company which is building a railway from Paranagua to Curytiba (Brazil) has failed to make the "administration" plan succeed, and has let out the work to local contractors.

Railroad work seems brisk in Brazil. The government has advertised for proposals for the extension of the Don Pedro II. Railway from Barbacena to Itabira do Campo—a distance of 104 kilometers. A concession for fifty years has also been awarded for building a line between Mamamguape and Acary. The Collins and Bently concession has lapsed, and will be carried out by another contractor.

MEXICAN NEWS.

HAVANA, March 8.—The English steamer from Vera Cruz brings the following intelligence from the City of Mexico:

The Government has ordered the state of Campeachy to construct a railroad and a telegraph line between Campeachy and Kuakini, with permission to extend the same to Lerma.

General McCauley, of Indianapolis, Ind., has arrived at Puebla. He intends to furnish Puebla and Guadalara with gas.

The construction of a narrow-gauge railroad to Vera Cruz is now considered a certainty.

Parties from Syracuse, N. Y., are visiting Frisbie's El Oro mines. Several rich ledges have been struck in the Pachuca district.

The Government is preparing a grand reception to General Ord.

It is reported that a number of Germans from San Francisco will settle in the neighborhood of Acapulco, where they are obtaining land at 40 cents per acre, payable in ten years. The Government has granted to General Manuel Castro, of California, forty-two leagues of land between the Yaqui and Mayo rivers, in Sonora, for a California colony.

WOODEN TRESTLE BRIDGE OVER THE HURON RIVER, AT ANN ARBOR, MICH.*

BY PROF. CHARLES E. GREENE, OF MICHIGAN UNIVERSITY.†

This bridge, built during the past season, carries the Toledo, Ann Arbor & Grand Trunk Railway over the Michigan Central Railroad and the Huron River. It describes a curve of 1,433 feet radius, is 980 feet long, and the rails are 33 feet above the water in the mill-pond where the crossing is made. The whole bridge is on a level grade.

At its southerly end, this bridge crosses a highway, with a clear span of forty feet, and is supported on two timber piers, each five feet wide, set on a skew of thirty degrees. The depth of the truss at its middle is four feet, and the head-room beneath is between thirteen and fourteen feet. Next, it crosses a side track of the T., A. A. & G. T. R., and soon reaches the M. C. R. R. yard. Here the bents are placed on a skew of from thirteen to fifteen degrees. Two openings of fourteen feet are left for possible side tracks, and the three tracks of the M. C. R. R. are passed by an opening of fifteen and one-half feet and a truss span of thirty feet. Twenty and one-half feet in the clear above the rails are here given. The portion over the river, 774 feet long, has the bents set radially to the curve, at a uniform distance apart of twenty-four feet. The side elevation of part of the bridge is shown in the accompanying sketch, and also a view of one of the main bents.

All of the trestle bents are supported on large white-oak piles, four to each bent, on land and in shoal water, and six piles to each bent in deeper water. In addition, two piles are driven in each row in the mid-stream portion to serve as ice-breakers. The greatest depth of water is thirteen feet. The bottom is compact gravel and sand, with some stones, which interfered a little with the pile-driving. All piles were driven to refusal, with an 1,800-lb. hammer, and the general penetration was from eight to ten feet. They were cut off about four feet above the water, and capped with a 12×14 white-oak stick, secured by tenon, mortise and wedge. The feet of the trestle posts are tenoned into the pile caps and pinned, a drip being bored in the mortise. No tenons and mortises are found in the remainder of the superstructure, but the timbers are gained and bolted. Special castings are used at the feet of the braces, to avoid cutting the posts.

The deck of the bridge is nearly twelve feet wide inside the guards, which are gained and bolted six inches from the ends of the ties. The ties are 6×8 in average section, fourteen feet long, and spaced fourteen inches between centers; they are cut tapering, eight inches thick at one end, and four inches thick at the other, to give a cant to the rails. The stringers are six in number, all 8×14, supported every eight feet and breaking joints; in general, two are packed together under each rail, and one over each outside post. The transverse bearing beams rest on the bolsters, which are four in number, one over each post, and supported also by braces. Lateral bracing just below the stringers takes up the centrifugal force of the train and resists wind pressure. The bridge is designed to carry an engine safely when derailed and close to the guard-rail. It is believed that the effect of any concentrated weight on a cross-bearer is distributed by this design over several points.

With the exception of the piles, pile-caps, ties and guard-rails, the bridge is built of white pine. The pile-driving was done at a fixed price per pile; all other work was done by the day. All joints were painted before the timbers were put together. Work was begun in the latter end of August, and the bridge was practically completed early in November, 1880, the actual working time being very nearly sixty days. The shore bents were raised by a gin-pole, and those in the river by a traveling frame, running on ways laid on the ends of the pile-caps.

The following facts should be noticed in comparing the cost of this bridge with that of other structures: The city of Ann Arbor prescribed that thirteen and one-half feet headway should be given over the street, that the span should be forty feet, and that the piers should be parallel with the street. Four feet only remained from the top of the stringers to the bottom of the truss. In order to retain the width of the deck and to avoid the use of heavy floor timbers, it was thought best to place the trusses below grade, to introduce four of them, and thus render the support of the stringers uniform throughout the bridge. Hence arose the peculiar truss used, and the skew framing increased materially the bill for labor. The trestle bents in the M. C. R. R. yard were also placed on a skew. All of the piles, and most of the timber for 770 linear feet of the bridge were carried by hand across the three tracks of the M. C. R. R. Co., because that company declined to allow any materials to be rolled or hauled across their tracks; the transportation in this way of large oak piles thirty feet long, and pine timber of the scantling here employed, often interrupted by trains, made a large item in the pay-roll. There were also some delays in procuring timber, which hindered the efficient working of the crew.

The bridge was designed and superintended by the writer, as engineer of the T., A. A. & G. T. Ry.; the field-work was in charge of Chas. L. Baker, division engineer; and the framing and erection was directed by Mr. Henry Smith, road-master of the same road.

The itemized cost of the bridge was as follows:

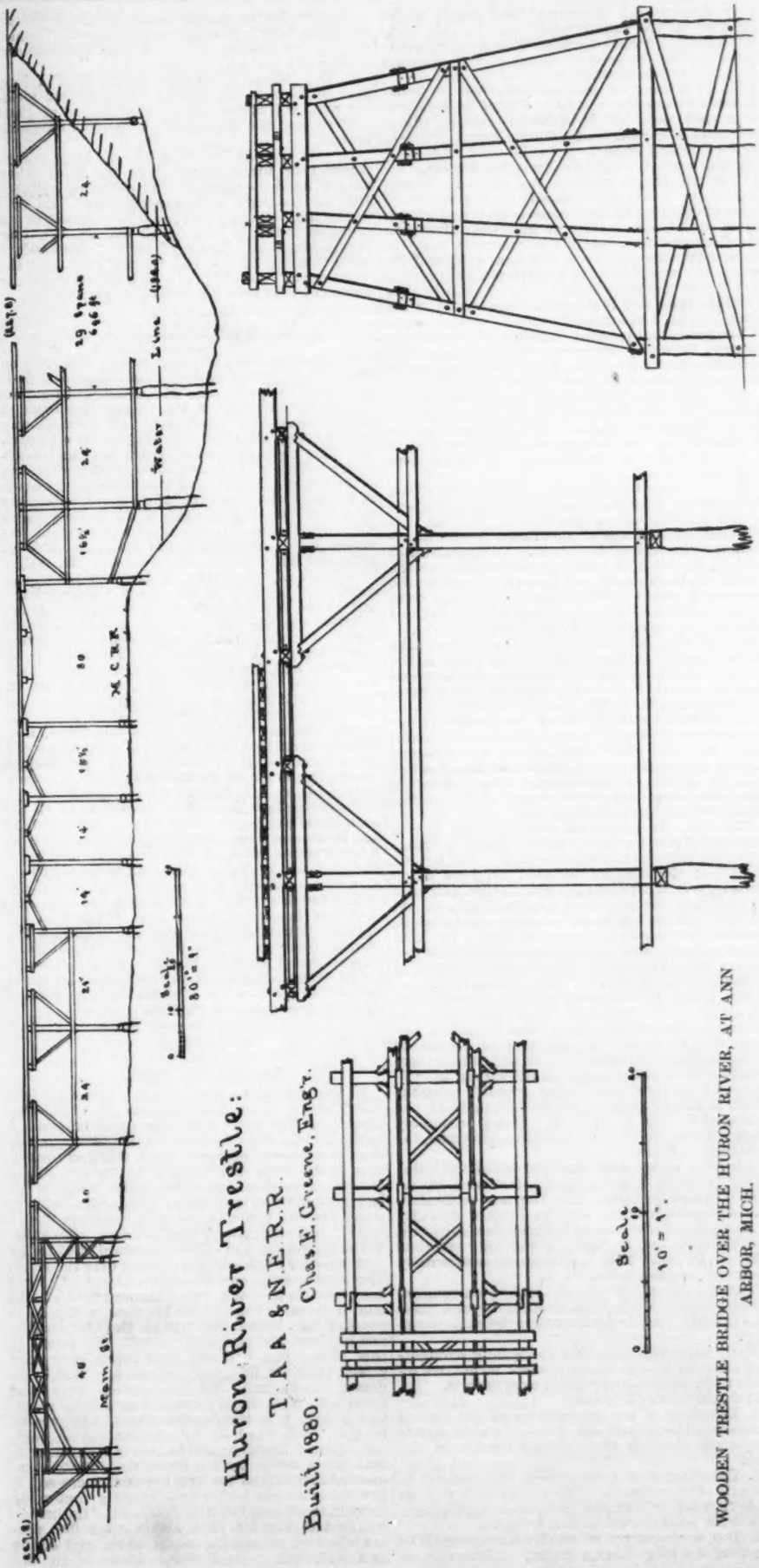
		Length	Pine at $18 per M.	Oak at $15 per M.	Wrought-iron at 3¾c. per lb.	Cast-iron at 3c. per lb.	Totals.
Main st. truss, etc.		66 ft.	16,582 ft. = $298.48	4,906 ft. = $73.59	3,111.7 lbs. = $116.65	3,773.3 lbs. = $113.20	$601.92
Main st. to river		140 ft.	26,923 ft. = 484.61	10,192 ft. = 152.88	5,663.3 lbs. = 210.12	6,027.2 lbs. = 180.82	1,028.43
River spans		774 ft.	170,831 ft. = 3,074.96	60,196 ft. = 902.94	12,103.8 lbs. = 456.14	34,424.8 lbs. = 1,032.74	5,466.78
			214,336 ft. = $3,858.05	75,294 ft. = $1,129.41	20,877.8 lbs. = $782.91	44,225.3 lbs. = $1,326.76	7,097.13
Extra timber			101.31		27.10	9.51	137.92
Total							7,235.05
Superstructure							$7,235.05
Piles, 218, 30 feet long at 11 cts. per foot							719.40
Driving 216 piles at $2.25							490.50
Labor							3,648.61
Total cost							$12,093.56

Cost per foot, $12.34.

Cost of materials above piles: Main st., $9.12 per foot; M. C. R. R. yard, $7.34 per foot; river, $7.06 per foot.

*The working drawings were exhibited at the convention, and some details of design and construction were then pointed out, which are here necessarily omitted.

†Paper read before the Michigan Association of Surveyors and Civil Engineers, at a meeting held at Lansing, Mich., on Jan. 11-13, 1881.



WOODEN TRESTLE BRIDGE OVER THE HURON RIVER, AT ANN ARBOR, MICH.

THE STRENGTH OF WROUGHT-IRON COLUMNS.*

BY G. BOUSCAREN, MEM. AM. SOC. C. E.

The construction of the bridge over the Ohio River for the crossing of the Cincinnati Southern Railway in 1875, and the subsequent letting during the same year of the contracts for nineteen other iron bridges and viaducts for the same road, including the important structures over the Kentucky and Cumberland rivers, were the occasion of my first experiments on the strength of wrought-iron columns.

Gordon's and Rankine's empirical formulæ, deduced from Hodgkinson's experiments on solid bars of small sizes, and used almost exclusively by American engineers for the determination of the sectional areas of compression members, are as follows:

$$\text{Gordon's } \frac{P}{S} = \frac{f}{1 + \frac{a l^2}{h^2}} \qquad \text{Rankine's } \frac{P}{S} = \frac{f}{1 + \frac{a' l^2}{r^2}}$$

P = Ultimate load in pounds, producing the crushing or bending of column.
S = Sectional area of column, in square inches.
f = Constant, supposed to be equal to the ultimate resistance per square inch of a short column whose whole length is equal to its diameter.

a = Constant
- For columns with flat bearings at ends..... = $\frac{1}{3000}$
- For columns with flat bearing at one end and rounded at the other..... = $\frac{2}{3000}$
- For columns rounded at both ends..... = $\frac{4}{3000}$

a' = Constant
- For columns with flat bearings at both ends.. = $\frac{1}{24000}$
- For columns with flat bearings at one end and rounded at the other = $\frac{2}{24000}$
- For columns rounded at both ends..... = $\frac{4}{24000}$

l = Length of column in inches.
h = Diameter of column in the direction of its greatest deflection.
r = Radius of gyration of cross section of column in direction of its greatest deflection.

Gordon's formula, the more popular of the two, seemed to be accepted without sufficient experimental evidence of its correctness, as applied to a great variety of shapes, almost every individual bridge-builder having his preferred value for constant "f."

In preparing the specifications for the above-named structures, I prescribed Gordon's formula, with the proviso that experiments would have to be made to determine the value of the constant "f" to be used for each kind of iron and shape of column proposed by the contractors.

Thirty-four experiments were made during the year 1875 in accordance with these specifications, whereby columns and struts of various shapes and of the full size to be used in the structures were crippled under pressure in a hydraulic press.

The following table gives the sizes and other characteristics of each of the columns tested, the results of each test, and the corresponding calculated value of the constants for Gordon's and Rankine's formulæ.†

In 1877, two experiments not here tabulated were made on the occasion of the construction of the bridge across the Tennessee River for the Cincinnati Southern Railway, to verify the assumption made in the calculations that an open column composed of two channel bars latticed should be calculated by Rankine's formula, with the same constant as for a closed column composed of channel bars and plates of the same kind of iron.

In 1878 and 1879, similar latticed posts having been adopted in the designs of the thirty-four iron structures contracted for by the Keystone Bridge Company, for the completion of the road, other experiments were made to test the result previously given by the two experiments just referred to, and to regulate the spacing of the lattice bars and the thickness of metal in the channel bars.

In all these experiments the posts were placed horizontally in the press, without any intermediate guide or support, excepting a counter-balance in the centre, of about one-half their weight. The pressure, recorded by a mercurial gauge, was applied by increments of from 1,000 to 2,000 pounds

* Read before the American Society of Civil Engineers, Sept. 1, 1880.
† This table was published in ENGINEERING NEWS of Jan. 29, 1881.

per square inch of sectional area of column, and completely released between each application.

The vertical and lateral deflection and the compression of the column under each application of pressure, and its permanent deformation after each release, were carefully measured.

Figures 1 to 4 (see "Transactions of the American Society of Civil Engineers, December, 1880,") show the apparatus used for measuring the compression.

A brass frame F bears a lever $m\,l\,n$, the long arm of which commands, by means of rod $m\,v$, a vernier v, moving on a graduated inch scale $g\,r$. The small arm bears an articulated rod $n\,p$, forked at the loose end p. Two footings $S\,S$, at the bottom of frame F, allow of its being fastened by means of clamp screws onto a wooden bar $A\,B$, made fast at one end to flange $f\,f$ of columns by clamp C, and moving freely at the other end through clamp D as a guide. Clamp D is fastened to the flange of the column at such a distance from frame F as will allow the forked end of rod $n\,p$ to bear on a small pin p, borne by clamp D.

A small weight W maintains the contact at p. The distance, moved by point p, being the compression of the length L of column between clamps C and D, is multiplied ten times on scale $g\,r$; the vernier reading the $\frac{1}{100}$ of an inch, the compression is observed to the nearest $\frac{1}{1000}$ of an inch, which for a length of twenty feet and a modulus of 24,000,000 corresponds to a pressure of fifty pounds per square inch.

After all parts had been brought to a good bearing by the first application of pressure (from five to eight thousand pounds per square inch), there was generally no permanent deformation observable until a pressure had been reached of about 15,000 pounds per square inch for the long columns, when a slight permanent set in deflection and compression would usually appear simultaneously and increase gradually until the crippling point was reached, when the column would yield faster than the pressure could be maintained by the pump.

The compression of the column during the period of perfect elasticity was carefully noted and used for the determination of the modulus. The modulus thus obtained is undoubtedly somewhat smaller than the modulus of the metal, a part of the observed compression being due to the bending of the column, but this error of observation being nearly the same for all columns of the same length does not affect materially the comparison of the results. The same may be said of the influence of the neglected friction of the plunger, and of the vibration due to the close proximity of heavy working machinery in the shops where the experiments were made.

These experiments, although very incomplete, and made under somewhat unfavorable circumstances, have enabled me to accomplish substantially the object for which they were instituted, viz., the proportioning of the compression members in the structures built by different contractors with the same margin of safety, and they have led me to the following conclusions, derived from a careful comparison of results obtained.

1st. As between Rankine's and Gordon's formulæ, Rankine's is the more accurate of the two. This is shown by the results of the tests on the Phœnix and closed square posts, where, the parts being thoroughly united together, the large factor due to the defective construction and workmanship may be considered as eliminated in a great measure. These results compare as follows:

EXTREME VALUE OF CONSTANTS OBTAINED FOR PHŒNIX POSTS WITH FLAT ENDS.

	Rankine.	Gordon.
Largest value	49,400	57,500
Smallest value	41,100	43,700
Difference	8,300	13,800
	Less than 17 per cent.	More than 22 per cent.

EXTREME VALUES OF CONSTANTS OBTAINED FOR SQUARE CLOSED POSTS WITH FLAT ENDS.

	Rankine.	Gordon.
Largest value	39,800	47,300
Smallest value	38,300	39,800
Difference	1,500	7,500
	Less than 4 per cent.	More than 15 per cent.

2d. Iron of the highest modulus does not necessarily make the strongest column.

This conclusion, which is at variance with the opinion entertained by many engineers, is shown in a remarkable manner by the same experiments on the Phœnix and closed square posts, where not only do the values of constant "f" fail to follow any proportional relation to the corresponding moduli, but the greatest value of "f" obtained for the Phœnix posts actually corresponds to the smallest modulus. It is proper to state here that although the average moduli of the Phœnix and square posts were very nearly the same, the iron in the two kinds of posts differed widely as to other characteristics, the Phœnix iron being a very close-grained, fibrous and hard metal, whilst the iron of the square posts was comparatively soft and of a coarser texture, which explains the difference in the average values of "f" obtained for these two kinds of posts.

3d. It is essential in built columns to fasten thoroughly together the several parts or segments, that they may act in a solidary manner as one continuous metallic body, and to guard not only against lateral flexure or buckling of each part, but also against longitudinal relative motion.

The importance of these conditions is demonstrated by the great variation in the results of tests of columns of the same length and shape, made of the same quality of iron, but differing in the fastening together of their several parts, as shown by experiments 3 and 8, and 25 and 31, where the substitution of close riveting at the ends in place of cast shoes bolted on made a difference of 22 per cent. and 17 per cent. respectively in the strength of the columns.

The anomalous result of test No. 19, where the column failed by flexure in the direction of the largest radius of gyration, is also due very probably to the insufficiency of the riveting.

4th. A due regard to the economy of material demands that the thickness of the metal and, in built columns, the spacing of the rivets, be so proportioned that the column shall fail by flexure as a whole, before any local buckling or flexure shall take place.

This is well illustrated by experiments, which are not here tabulated, instituted for the purpose of determining the largest spacing of rivets and the smallest thickness of metal allowable for a particular style and length of post. Columns Nos. 37 and 38, having both failed by the buckling of the metal in the channel, and the local flexure of the channel between rivets, pieces of channels were tested of the same shape and sectional area as those used in the posts, and of lengths equal to the distance between the lattice rivets; they failed in the same manner as the channels had failed in the long columns, but under somewhat higher pressure per square inch, confirming the first results.

Column No. 41, in all respects similar to Nos. 37 and 38, but with thickness of metal slightly increased and spacing of rivets reduced to 20 inches, was then tried and failed by the simultaneous flexion and buckling of the metal in the channel and the bending of the column bodily, showing that the column was properly proportioned, being of equal strength in all its parts.

Test No. 42 confirmed No. 41, and it was established that for that ratio of length to diameter the thickness of the metal should not be less than $\frac{1}{40}$ of the distance between supports transversely, which confirms Fairbairn's rule, and that the distance between rivets longitudinally should be such that the length of channel spanning it, considered as a column, and calculated by Rankine's formula, shall give the same resistance per square inch of area as the column itself treated in the same manner with the same constant "f."

5th. It may be concluded from experiments Nos. 13, 14, 16, 17, 21, 36 and 43, made with columns hinged on pins at both ends, that Rankine's formula with constant "a" assumed at double its value as applied to columns with flat ends, is practically correct, the variation in the values of "f" derived from these tests, being probably attributable, in a large measure, to the difference in the fitting of the pin, a "close fit" giving invariably higher results, the friction resisting, of course, the tendency to flexion.

The very large variation of the calculated value of "f" for Nos. 36 and 42 must, however, be ascribed to another cause, viz.: The now well-established property of iron, that its limit of elasticity is increased after the metal has been once subjected to a strain beyond its limit of elasticity and then allowed to rest. This circumstance accidentally occurred for column No. 36.

Tests Nos. 6 and 18 were also made on columns which had previously been strained beyond their elastic limit, and further confirm the same property.

Many important questions concerning wrought-iron columns as used in our modern structures remain to be elucidated by direct experiments.

It would be useful to test:

1. The effect of the eccentricity of the line of pressure to the axis of the column, which occurs frequently through the unequal tension of tie-bars.

2. The effect of a force acting transversely to the axis of the column. This occurs as a rule in all horizontal or inclined compression members, and in all posts riveted to floor beams.

3. The applicability of the Rankine formula to the tiers of a long column guided at intervals, as is the case for the continuous posts of high trestles and piers held in line by the systems of horizontal and vertical bracing, the tiers being assimilable to neither flat nor pin-end posts.

4. The influence on the strength of a long post, of the support afforded by a stiff but yielding web, as it occurs for the top flange of plate girders and the top chord of partly over-grade trusses.

In this line of investigation our large bridge-contracting firms should take the lead. They have at hand the facilities for conducting leisurely and methodically such experiments. The contractor and the engineer should join hands in an endeavor to reduce from six to five or even four the irrepressible "factor of safety" invented to cover two large fields, the "incidental" and the "unknown," the limits of which should gradually contract under the light of well observed facts.

PAVEMENTS OF LONDON, ENG.

A report has been prepared by Mr. Haywood on the works executed by the Commissioners of Sewers during the past year. He says that at no time during the existence of the Commission have so many varieties of pavement, both carriage-way and foot-way, been laid as during the last ten years. The first asphalte pavement was laid in Threadneedle street in 1869, and since that year almost every sort of asphalte and wood pavement known in England which gave promise of succeeding has been tried. The vast increase in the traffic requires the hardest stone, if economical reasons alone prevailed; but the selection has fallen on materials for pavement which diminish the noise of the traffic. Wood and asphalte have, in fact, almost entirely superseded granite in the main thoroughfares; and in the minor streets, where the gradients are suitable, asphalte has been the material mainly used. The Commissioners are constantly trying experiments. A specimen of granolithic pavement was laid, for a length of 50 feet, in the footway on the southern side of Leadenhall street. This material is formed of crushed granite mixed with lime or cement and formed into slabs. The merits claimed for it are great durability, uniformity of surface, and absence of slipperiness under all conditions of weather. A specimen of Maninghen stone, from the Maninghen quarries, near Boulogne, was laid for a length of 50 feet in the footway of Leadenhall street, next to the granolithic pavement. The slabs of this stone are laid in courses 2 feet wide, varying from 2 feet to 3 feet 6 inches in length, and are 2½ inches thick; the joints are very fine, the stone being sawed on all sides and edges. It is a calcareous sandstone, with a fine close grain, and is said not to laminate. A 50-foot length of 3-inch York flagging of the ordinary description was also laid adjoining the Maninghen stone. This will enable the relative durabilities of the three kinds of pavements to be tested—the traffic over them being about the same, and all having been laid at about the same time.—*London Architect, Feb.* 26, 1881.

NOTES.

THE NIAGARA BRIDGES.

In response to the inquiries of a correspondent the Niagara Falls *Gazette* gives the following sketch of the history of the great suspension bridges: "In 1848 Charles Ellet, a brilliant, rather than a profound, engineer, built the first suspension bridge over the Niagara, on the site of the present railroad bridge. The bridge was only for carriages and foot passengers. The towers were of wood, and the roadway was only about six feet in width, just wide enough for one team. Mr. Ellet, in the beginning, had offered a reward of $5 to the first person who should get a string over the river. The next windy day a large number of boys assembled on the bank with kites, and before night one of them, Homan J. Walsh, then a boy of 13 years of age, landed his kite on the Canada side and received the promised reward. By means of this string larger cords, then ropes, then iron cables, small at first, but increasing in size, were drawn across, until the large cables were thus stretched. This structure served as a most excellent auxiliary in the construction of the present bridge. This was built by America's great engineer, John S. Roebling, and has always been considered one of the greatest of his works. It was commenced in 1852, and the first locomotive crossed it in 1854. The iron basket now hanging under the railroad track near the American end of the bridge was first used by Mr. Ellet, and in it the first person who ever crossed the chasm alive, and of his own will, was crossed over. There is an old

Indian tradition that a resisting chief was once carried to the opposite side by a large bald-headed eagle, who swooped down on the great warrior, as he lay in ambush on the ground, and bore him over. Ladies have crossed in this basket. The suspension bridge by Brock's monument was built in 1856 by T. E. Serret. The ice jam of 1866 tore the guys from the rocks to which they were fastened, and before they were replaced a terrific gale broke the roadway, severed the suspenders, and left the structure dangling in the air. The new suspension bridge, as it is called, was built in 1868, the cables being carried over in the winter on the ice-bridge. Its length is over 1,200 feet, or a full quarter of a mile, from outside to outside of the towers, and is the longest suspension bridge in the world."—*Boston Post Feb.* 18, 1881.

ON THE RUSTING OF IRON.

Dr. T. L. Phipson sends the following note on the rusting of iron to the *Chemical News:* "A correspondent asserts that in making some photographic experiments he found that iron and steel do not rust when immersed in solutions of caustic soda and caustic potash, but he appears to have been unable to discover any explanation of the fact in the books and journals to which he has access. 'I can't understand,' he says, 'why the alkali in the solution prevents the oxygen in the water acting on the iron or steel.' The fact has been known for a great many years, and the true explanation was pointed out, I believe, for the first time by the late much regretted Dr. Crace-Calvert, to whom modern chemistry is indebted for much useful work. Dr. Calvert's explanation is in strict accordance with the theory propounded some years previously (1858) in my paper on catalytic force. His experiments showed that the phenomenon of the rusting of iron was due to the presence of carbonic acid, this body forming the third substance requisite, according to my theory of catalysis, to complete the galvanic chain. Without the presence of this carbonic acid, or some third substance capable of taking its place, the oxygen cannot combine with the iron at ordinary temperatures. A high temperature acts like electricity in promoting the combination. As long as there is free caustic alkali present, of course there can be no carbonic acid, and no rust is formed."

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Newburyport, Mass., expects to introduce the Holly system of steam heating.

The Allegheny Water Committee will have plans prepared for supplying the hill districts with water.

The reservoirs at North Adams, Mass., are full and water is abundant, but still it is an open question whether the town ought not to do something to prevent a failure in the future.

The Chapman Valve Manufacturing Company have the contract for all the gates, hydrants, and valves for the Wilmington, N. C., water-works. They have also the contract for supplying the same appliances for the Newburyport, Mass., water-works, now being built by the well-known contractor, Geo. H. Norman.

The Pittsburgh people are not satisfied with the present organization of the water-works department. A superintendent will now be responsible for the supply of water. A proposition to lease the water-works brought out the remark that the people of Pittsburgh required a great deal of the liquid to keep their faces clean.

The contract for furnishing 28 miles of pipe for the Springfield, O., water-works was awarded to the Warren Foundry and Machine Co., of Philadelphia, at $30.61 per ton, delivered; all bids for laying were rejected, and will be readvertised; the hydrants were divided between the Chapman, Boston Machine Co. and R. D. Wood & Co.; the valves were divided between the Chapman, Ludlow, Mohawk & Hudson and Boston Machine Company.

The American Rapid Telegraph Company at a meeting of stockholders in this city on the 9th, voted to increase its capital stock to $10,000,000, and to extend its lines to the principal cities in the United States. The directors at a subsequent meeting requested the treasurer to offer the $6,000,000 of increased stock to stockholders of record of the 15th inst., pro rata, at par, the right to expire on the 25th inst. They also authorized the President and Executive Committee to make contracts for extension at once.

On the 14th ult., an election of taxpayers was held in the village of New Hartford, N. Y., to vote upon a resolution to contract with the New Hartford Water-Works Company for a supply of water for fire purposes, at $500 per annum. The resolution was lost by a tie vote—27 yeas, 27 noes. The number of hydrants was to be 15 origmally, and additional ones to be put in whenever the company might extend its pipes, the hydrants themselves being the property of the company. The price per hydrant would have been $33.33, which rate would have been reduced as the number of hydrants was increased; the price, $500 per year, being a constant and fixed sum. Utica pays about $50 per hydrant, Schenectady $125, West Troy $100, Green Island $100. It was proposed at New Hartford to make the minimum rate to consumers $10 per year, which was to be for 200 gallons per day, and any excess at the same rate —14 cents per 1,000 gallons, meters being attached in every case. The rates per 1,000 gallons in some other places, for quantities as small as 200 gallons per day, are: Utica, 50 cents; Johnstown, 25 cents; Albany, 40 cents; Syracuse, 40 cents; Schenectady, 50 cents; Binghamton, 25 cents; Rochester, 30 cents. The water was to be filtered.—*Daily Observer, Utica, N. Y.*

Extract from report of Davis Kitch, Superintendent Lancaster (Pa.) Water-Works, for year ending Feb. 28, 1881: I would recommend the adoption of the water meter as the only proper method by which to assess water rents. If meters are introduced and the consumption of water is the same as it is to-day, and the city were to charge one cent per hundred gallons, the revenue from water rents would be $90,000 a year, or over $50,000 more than at present. If the meter system is adopted there would be more care and a saving possibly of 33 per cent. in the water consumed, still leaving a revenue to the city of $60,000. By this system the small family, economical in the use of water, would have but a nominal water rent to pay, while the heavy manufacturers and corporations, who use millions of gallons of water annually, will pay for just what they use or waste, and no more. The greatest advantage of their introduction would be that for years to come you save a vast outlay for improvements at the water-works which cannot be avoided if the increase in renters in the next seven years is as great as it was in the last seven years. The only thing that can be urged against the system is that it is expensive. A trial should be given by the introduction of a few, and if it is found that the system is advantageous to the city, then meters should be furnished to all renters. The average daily consumption of water during my term was 2,903,706 gallons. Our population is 25,846, making our per capita consumption 112 gallons. This is exceeded by but one city in the United States that we have statistics of—Pittsburgh. In New York, Philadelphia, Chicago, Cincinnati, Boston, St. Louis, and a dozen other large cities, it is but 65 gallons per capita on an average. In twenty-one large foreign cities it is but 25 gallons per capita. Providence, R. I., with four times the population of Lancaster, uses but little more water than we do, and the small per capita consumption is accounted for by the meter system of charges.

ELECTRICITY.

The French Government proposes to employ the electric light in forty-two light-houses along the coast, where oil till now has been used. Up to the present time there are but seven electric light-houses in the whole world, three of which belong to France.

Rear Admiral Nichols, inspector of the Third Light-house District, announces that an automatic buoy, having a ten-inch whistle and a glass globe for an electric light on the top, has been moored near the Sandy Hook Light-ship. The inventor of this buoy claims that it will show an intermittent electric light, the generator being operated by the action of the waves.

STREETS, DRAINAGE, ETC.

The Philadelphia Council Committee on Surveys has reported favorably on the construction of several sewers.

BRIDGES.

The Monongahela Bridge Company, which lately passed into the hands of Dr. Hostetter, has been reorganized and a board of directors chosen.

SILICATE WHITE PAINT.—The high regard for this paint is shown by the following testimonials:

OFFICE OF ENGINEER AND ARCHITECT,
RECONSTRUCTION OF PATENT OFFICE BUILDING,
WASHINGTON, D. C., Feb. 18, 1881.

Mr. Howard Fleming, 23 Liberty street, New York:

SIR: I have used your silicate paint throughout for all painting in this work, and am glad to state that the claims of the manufacturers as to the superiority of this material, combined with economy, have been fully justified by the result obtained, in all respects.

Very respectfully yours, ADOLF CLUSS.

GREENVILLE, Conn., Feb. 19, 1881.

Howard Fleming, Esq.:

DEAR SIR: Your favor of the 15th inst. received. I have only used silicate white paint for inside work. It does all you claim for it. It will cover better, go farther, and will stay white. I have tried it, in contrast with the best French zinc, on two adjoining rooms, with large folding doors between. The silicate is as white now as when first put on, while in the next room the zinc is as yellow as can be; and this I state after a three years' trial. For outside work I am not prepared to give an opinion, as I have just begun to use it outside. Have just painted two houses with it. I use the silicate in preference to all other paints, believing it to be the best and the cheapest.

Respectfully yours, E. P. GARDNER.

STATE OF NEW YORK,
WILLARD ASYLUM FOR THE INSANE,
WILLARD, SENECA LAKE, Feb. 23, 1881.

Howard Fleming, Esq.:

DEAR SIR: After examination, we felt so much confidence in the adaptability of your silicate and enamel to hospital wards and public rooms, that we have covered the walls and rooms of thirty-four wards, and shall apply it to the remainder of our wards.

We have sufficient confidence in it to continue its use.

Yours truly, M. J. GILBERT, Steward.

If equal weights of silicate white and white lead are taken, thinned down in the usual manner, and applied upon two equal measured spaces, it will be found that 6 lbs. 6¼ ozs. of the silicate white does as much work as 8 lbs. 9½ ozs. of genuine white lead, apart from the fact that the silicate white covers with a much denser coating.

RAILROADS.

Mr. Toombs, the constructor for ten miles from the Brazos (Texas) line, has begun operations.

The oil country railroad men propose to have a new line from Warren to Bradford. A corps of engineers are at work laying the route. Two companies are endeavoring to secure the privilege.

It is announced that the first through San Francisco passenger train via the Atchison, Topeka & Santa Fe Railroad will leave Kansas City and Atchison on regular card time on Thursday, March 17.

The track of the Cincinnati Northern Railroad has been completed from Norwood, on the Marietta & Cincinnati Railroad, to Lebanon, O. Regular trains will not be run until the road has been ballasted.

It is not generally known that the Cedar Falls & Minnesota road, its $1,000,000 stock, is the St. Paul outlet of the Illinois Central. The future of this division is as auspicious as the Southern division owned by that road, known as the Chicago & New Orleans.

A dispatch from Pilot Point, Texas, says: "Tracklaying on the Transcontinental Railway was completed to this point March 2. Denison is now connected with the North via Denison or Sherman, and a gap of only six miles remains between here and Denton, when the city will have another railway outlet via Dallas."

The Buffalo, Pittsburgh & Western road distributed along the cross-cut division twenty car loads, 200 tons, of English steel rails, the first consignment of an order for 500 tons made some time ago. The new rails will be put in place as soon as Spring opens.

Among the securities admitted to the Stock Exchange of this city are the $8,750,000 of the stock and bonds of the Toledo, Delphos & Burlington Narrow-Gauge Railroad, being the entire capital liability of 285 miles of road. The road is the nucleus of a narrow-gauge system that is being extended to and beyond St. Louis with the view of establishing a narrow-gauge trunk line from Lake Erie to the Southwest.

The Galveston *News* gives the following account of work on Texas roads: Mr. J. B. Langford, of Frio County, reports the International Railroad hard at work for forty miles west of San Antonio. A portion of the Sunset surveying corps are at Fort Clark, for the purpose of locating the route for the extension of that road. The movement toward procuring subscriptions to the Nueces Valley Railroad has met with gratifying success.

The St. Louis & Eastern Railroad Company has filed articles of incorporation with the Secretary of State of Illinois; capital stock, $400,000; incorporators, Victor Sherman, J. C. Sinclair, Henry Sutton and S. H. Parker, of St. Clair County, and Andrew Donnan, Horace A. Stephens and Eber Peacock, of St. Louis. The object is to construct and operate a road from East Carondelet in a southeasterly direction to Georgetown, in the county of St. Clair.

On the 8th inst. the Brooklyn Rapid Transit Company applied to the Brooklyn Board of Aldermen for permission to build on the routes laid out by the second rapid transit commission. These embrace Adams street, Myrtle avenue, Fulton street from City Hall to East New York, Flatbush avenue to Atlantic avenue, Fourth avenue to Prospect avenue, and thence to the city line in Ninth avenue. The petition of the company was referred to the Railroad Committee.

A dispatch from Columbia, S. C., says: "The work on the Savannah Valley Railroad is being pushed with vigor. When completed, this road will open some of the finest sections of the State, which are now undeveloped. Interest in the completion of the old Blue Ridge Railroad, the connecting link between Charleston and the great West, is being revived by the press. Thirty-three miles of this road have been built in South Carolina. It is expected that the Clydes, who own the Columbia & Greenville, and the Charlotte, Columbia & Augusta railroads, will push up the Blue Ridge."

A Nashville dispatch says: "A meeting of the Board of Directors of the Nashville, Chattanooga & St. Louis Railway, was held March 4, to inaugurate measures to put the property of the road in good order. The road is in rather a poor condition from Chattanooga to the Mississippi River, and needs ditching, ballasting, new cross-ties, new bridges and new equipment. The object of the meeting was to raise a sufficient amount of money to make the road first-class, and to put it in such condition as to compete with any road in the Southwest. The board gave President Porter power to go ahead and provide means to do all this. Mr Porter stated that he had made no arrangement yet to secure the needed financial aid, but as he had received instructions from the board he would carry them out as soon as possible."

The following are the miles operated by the Central Pacific Railroad Company, of which Mr. S. S. Montague is Chief Engineer, with office in San Francisco:

Central Pacific Railroad	1,214
Southern Pacific Railroad (south of Goshen)	552
Los Angeles & San Diego Railroad	28
California Pacific Railroad	140
Northern Railway	82
Stockton & Copperopolis Railroad	49
Amador Branch Railroad	27
Los Angeles & Independence Railroad	17
Berkeley Branch Railroad	3
Steamer lines, Sacramento River	294
Steamer lines, Colorado River	365
Total miles,	2,771

The annual meeting of the Chicago, St. Louis & New Orleans Railway Company was held at the office of the company in New Orleans, March 2, 75,492 shares being represented. The shareholders approved the actions of the directors during the year past, and ordered all the revenues derived from working the road, beyond the absolute necessary expenses, and the interest on the first mortgage and earlier bonds, be applied to the improvement of the property during the present year, and the necessary arrangements be made to change the grade at some convenient period during the coming summer. The Vice-President, Mr. James C. Clark, stated to the meeting that pursuant to the instructions of the shareholders at their annual meeting, the improvements had been made with as much rapidity as was consistent with due economy; that owing to the scarcity of labor, and, at times, to the rainy weather, it had been out of his power to prosecute these improvements with the rapidity desired at the last meeting, but that during the year 11,929 tons of steel rails had been laid in the track, and 200 freight cars had been built; that the rolling stock now stands, 101 locomotives, 1,843 freight cars and 70 passenger, baggage and mail cars; that about eighty-five miles of track had been ballasted and about 30 miles of fencing had been erected; that a very important reduction of grades had been effected, reducing many of the grades upon the road to 35 feet; that this had enabled them to widen the embankments, and that upwards of 100,000 cubic yards of material had been distributed in this way; that the ties placed on the track during the last three years amounted to about 666,000, or 1,200 ties to the mile; that about two and one-half miles of the trestle bridges between East Cairo and Jackson, Tenn., had been filled to a very large extent, and that the road was in every respect in a safer and better condition than at any previous date; that the directors had recently purchased 12,000 tons of steel rails, making 44,000 tons, of which about 4,500 tons had been distributed and put in track since Jan. 1; that several cargoes were in transit from New York, and that he hoped to have this 12,000 tons in the track by June 15, requiring only 5,000 tons to replace the entire track with steel rails; that these 5,000 tons had been purchased of the Bethlehem Company, at $57.50 per ton, for delivery in May, June, July, and August; if the season is favorable the management expected to have the track finished with steel the coming autumn; that purchases had been made of machinery and tools necessary to alter the engines and cars to the gauge of the roads north of the Ohio River; that the expense beyond that already incurred to make this change of gauge would probably be $200,000.

It was announced at the annual meeting of the stockholders of the Pennsylvania Railroad Company in Philadelphia, on the 8th inst., that the officers of that company had closed a contract with a committee representing the Boston interest in the Philadelphia, Wilmington & Baltimore Railroad for the purchase of a controlling interest in that road. The action of the officers was ratified. The transaction was a surprise to railroad and financial men in this city, for a syndicate of New York & Baltimore Railroad men and capitalists had closed a contract with Nathaniel Thayer of Boston, one of the largest stockholders of the Philadelphia, Wilmington & Baltimore Company, for a sufficient amount of stock to control the road. The syndicate was composed of John W. Garrett, President of the Baltimore & Ohio Railroad; Jay Gould, August Belmont, G. G. Haven, John Jacob Astor, Wm. H. Vanderbilt, and others. The contract with Mr. Thayer called for the delivery of about 120,000 shares of the stock at $70 per share on or before March 15. This is a larger amount of stock than Mr. Thayer owned, but it is said that he made the contract expecting that his townsmen and friends, whom he had induced to invest in the stock when it was at a low figure, would aid him by selling their shares with his at the same figure. As the stock is issued in shares of the par value of $50 each, the price per centum agreed to by Mr. Thayer was 140. It seems, however, that Mr. Thayer overestimated the co-operation of his townsmen, for a committee representing 90,000 shares came to this city on Monday afternoon, met President Roberts, of the Pennsylvania road, and before midnight they had contracted to deliver him the 90,000 shares at $80 per share. The contract also binds the Pennsylvania Company to take from all holders of the stock such shares as they may send in before April 1 up to the entire amount of the capital stock of the company, at the same price, $80 per share. The par value of the capital of the Philadelphia, Wilmington & Baltimore Company is $12,000,000. As it is not believed that any of the outside shareholders will fail to accept this offer, in view of all the circumstances, the investment will cost the Pennsylvania Railroad $19,200,000. This is exclusive of the bonded debt of the purchased road, which is $3,000,000. The Pennsylvania Company will keep the organization of the purchased road separate from its own.

The Boston *Transcript's* financial article says Nathaniel Thayer has settled his Philadelphia, Wilmington & Baltimore stock contract with the Gould-Garrett syndidate by the payment of half a million dollars cash.

It was also announced that the Baltimore & Ohio Company has subscribed $4,000,000 toward building a new line parallel with the Philadelphia, Wilmington & Baltimore, from Baltimore to Philadelphia, at a cost not exceeding $7,000,000. This new line will compete with the P., W. & B. for local business, and, in addition, will take all the through Western and Southern business of the Baltimore & Ohio system. It will take West all business controlled by that line and the Reading and the Jersey Central roads, with which companies the Baltimore & Ohio has already made a compact by which each company gives to the new line its entire business. The new line will be 92 miles long, and can be built in nine months. A branch of the Reading road 13 miles long, running south from Philadelphia, will be utilized, and will aid in obtaining good terminal facilities in Philadelphia.

CANALS.

The act for constructing a narrow-gauge railroad on the berme bank of the canals of New York, for towing boats by locomotive in the summer and for freight trains when the canals are closed, has been reported adversely by the Senate Committee on Canals.

NEW PROJECTS.

The Lawrence Line Company, with $15,000 capital, to make line and cord, has been incorporated.

The Texas, Topolobampo & Pacific Railroad, with a capital of $30,000, has been chartered. Among the directors are Mayor Prince of Boston, Josiah G. Abbott, General Butler, George W. Simmons and Ulysses S. Grant, Jr., of New York.

WASHINGTON, March 10.—The ceremony of laying the first rail of the Washington City & Point Lookout Railroad took place at noon to-day at Brandywine, sixteen miles from this city. The road will be completed from this city to Point Lookout by August 1.

Articles of incorporation have been filed with the Secretary of State at Sacramento, Cal., of the Bodie Railway and Lumber Company. Place of business in San Francisco. Directors: H. M. Yerrington, A. J. Ralston, R. M. Graves, W. S. Wood, W. Willis, J. B. Low and J. M. Quay. Capital stock, $1,000,000.

Articles of incorporation were filed with the Colorado Secretary of State on the 10th by the Denver & New Orleans Railroad Construction Company. The capital stock of the company, $1,500,000, is divided into 15,000 shares of $100 each, $1,000,000 of which is allotted to Denver, and $500,000 of the stock is reserved for Eastern parties.

The West Coast Telegraph Company (limited), now operating cables to Peru, has completed arrangements to connect with the Central and South American Cable Company, via Panama, Central America, Mexico and the United States, to Europe, saving 8,000 miles of transmission and about $6 per word on business between points in the United States and the west coast of South America over the route now used, which is via Brazil and Portugal.

A bill is now before the Legislature of New Brunswick to incorporate "The Saint John Bridge and Railway Extension Company." They propose to erect a railway bridge across the St. John River, near the City of St. John, by means of which, with the construction of a mile or less of Railway, a connection can be made between the Intercolonial Railway and the St. John & Maine Railway. It is doubted, however, whether the Legislature has power to grant such a charter over a navigable river.

A company has been organized to build a railroad and general traffic bridge over the Ohio River between New Albany and Louisville. It is incorporated under the name of the "Kentucky and Indiana Bridge Company," capital stock $1,500,000, and includes among its directors several prominent railroad men. The length of the bridge will be 2,550 feet, or but little more than half the length of the bridge at the falls. The estimated cost is $1,200,000. It will be provided with tracks for wagons, street-cars and footmen, as well as a railroad track. The organization has been perfected under two charters, one from the State of Kentucky and one from the State of Indiana.

At a meeting of capitalists, held in Indianapolis last week, a company was formed to construct and equip a railroad to be known as the New York & Chicago Railroad, the corporation to have a capital stock of $10,000,000. The road will be 200 miles long, and will run from the east line of Allen County, Ind., in a northwesterly direction, via Fort Wayne, to the State line between Illinois and Indiana. It will pass through the counties of Allen, Whitley, Huntington, Wabash, Miami, Kosciusko, Marshall, Fulton, Pulaski, Starke, Jasper, Porter and Lake. The following are the officers: President, C. S. Brice; Vice-President, Wm. Fleming; Treasurer, Samuel Thomas; Secretary, James E. Neal. Directors: C. S. Brice, Samuel Thomas, George I. Seney, Walston H. Brown, C. R. Cummings, W. B. Howard, Wm. Fleming, James E. Neal and J. A. Latcher. It is reported that a connection with the Lake Erie & Western for the purpose of a through line to New York is intended.

The Galveston *News* says: "A company has been organized, under a name not yet known, for the construction of a narrow-gauge railroad from Galveston and Houston to the Rio Grande. Commencing at Houston—the center of the narrow-gauge system of the State—the road will run through the counties of Fort Bend, Wharton, Jackson, Victoria, Refugio and San Patricio, to the town of Corpus Christi, there to connect with the Corpus Christi, San Diego & Rio Grande Railroad, now being pushed by the Palmer-Sullivan syndicate to the Rio Grande. It is contemplated that the road shall cross the Brazos River on the bridge of the Gulf, Colorado & Santa Fe Railroad, at which point a Galveston connection will be made. In this event a third rail will be laid over the G., C. & S. F. from the Brazos River to Galveston. It is presumed that a permanent arrangement can be made with the management of the latter road, either by tariff on tonnage or lease of the line, so that the company can run trains into Galveston to its own depot in that city. The design is to make Galveston the terminus of an extensive system. The scheme will prove, when matured, another important link in the narrow-gauge system of the State, and will make Galveston the gulf outlet of the whole, independent of the other connections. The Palmer-Sullivan syndicate, of New York and Philadelphia, in conjunction with interests in Western Texas, are the movers in this matter. When carried out it will give a gulf outlet to the Mexican National Railroad, now being constructed by the Palmer-Sullivan party toward the Rio Grande. General Palmer, who is at the head of the movement, is president of the Denver & Rio Grande and Mexican National railroads.

The Atlantic & East Coast Canal and Okeechobee Land Company has been incorporated by the State of Florida. The company will be formally organized as soon as the charter arrives, which will probably be to-day. Hamilton Disston will be elected president, and other equally well-known and responsible gentlemen will be chosen to the other offices. The treasurership has been offered to W. H. Gatzmer, who will accept, if his age and his manifold business enterprises do not prevent him from engaging in this new work. The chief engineer will be a man who has a national reputation and is well acquainted with the Southern country. Mr. A. B. Linderman, who recently returned from Florida, will return next week, accompanied by a corps of engineers, who will immediately begin the work of running the levels for the canal. The actual work of dredging will be begun in thirty days, or as soon as the necessary machines can be placed on the ground. Patent steam dredgers, manufactured in Boston, will be used in the work of excavation. Each machine is capable of doing the work of two hundred men. The plan of the company is to dig a canal ten miles long from Lake Okeechobee to the head waters of the Caloosahatchie River. This river flows into the Gulf of Mexico, and its mouth is, according to the surveys made by Colonel Meigs of the Topographical Engineers, United States Coast Survey, and General Gilmore, 23½ feet lower than Lake Okeechobee. The work of the engineers is simply to drain the lake sufficiently to prevent its overflow. It is this overflow which causes the Everglades to be submerged with water, the lake having no natural outlet. The Everglades are surrounded by a limestone ridge which acts as a dam to the waters, and after the overflow of the lake it can only disappear by evaporation, which, of course, is a slow process. The ground is consequently almost continually under water. If the canal above mentioned does not sufficiently drain Lake Okeechobee to prevent its overflow, another canal to the eastward will be cut to the St. Lucie River, 12 miles long, which will carry the water into the Atlantic Ocean. The mouth of the St. Lucie River is 25 feet lower than the basin of Lake Okeechobee. It will thus be seen that the engineering difficulties can easily be surmounted and the lake drained sufficiently to prevent the overflow of its banks, which will make a garden spot of the whole Everglade country.

Articles of incorporation have lately been filed with the Secretary of State of Florida for a new road, to run from Tallahassee, Fla., to Pensacola and Mobile. Among the incorporators of this line are N. K. Fairbank; W. B. Strong, Vice-President of the Atchison, Topeka & Santa Fe; S. A. Kent, one of the directors of the Atchison, Topeka & Santa Fe Railroad, and Frank E. Shirwin, now President of the Maxwell Land Grant Company, a corporation owning 2,000,000 acres of coal, grazing and mining lands in New Mexico. It is the intention of the new company, which, in addition to the new lines from Tallahassee to Pensacola will also control the Florida Central from Jacksonville, Fla., to Lake City, and the Jacksonville, Pensacola & Mobile road, running from Lake City to Tallahassee and Chattahoochee, as soon as the possession of the now-completed roads can be obtained, to put them in good repair, and to commence and actively prosecute the work of extension through West Florida, with the ultimate view of connecting this line with the rapidly-extending railroad system of the West and Mexico, and particularly with the Atchison, Topeka & Santa Fe. This company had fully expected to make a connection with the Southern Pacific by the 1st of March, but owing to the unusual inclemency of the weather, and other obstacles encountered, the connection can not be completed until about the 15th. The connection will be made at Rio Mimbres, a few miles west of Florida Pass. The point is sixty miles southwest from Fort Thorn, where the Santa Fe road leaves the Rio Grande, and some sixty-five miles northwest of El Paso.

CONTRACTING, MISCELLANEOUS, ETC.

The *Arizona Miner* states that the miners of the Silver Belt mine have made a remarkable discovery, showing that the mine was worked ages ago. The ten-foot bonanza recently uncovered, continuing to widen at every stroke of the pick, left an overhanging wall on one side that appeared more like loam than the ordinary wall or vein matter of a quartz ledge, and so soft that it caved in such a way as to obstruct the work. They then went up above the cave and decided to run down on the ledge in a new place, so as to get under the cave, in order to have solid ground to work on, and in clearing away a place to start in they found lying on the ore, on top of the ledge in the soft loam, three feet from the surface, five stone hammers such as are found in the ancient ruins and abandoned mines of the Aztecs all over the country, showing clearly that the Silver Belt had been worked in prehistoric times. This is the first and only indication that has been found that the "Belt" was ever disturbed before the present owners uncovered it. One of the miners exhibited one of the hammers, which a miner had broken in order to see the quality of the stone of which it was made. The material is a dark, tough, slaty-looking rock, such as the ancients used in making all their hammers and axes.